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Host preference and digestibility indices of *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on different host plants under laboratory condition

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Abstract
The present studies were undertaken at Biocontrol Research Laboratory, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during 2019-20 to study the host preference and digestibility indices of *Spodoptera frugiperda* on different host plants under laboratory condition. The data on digestibility indices of *S. frugiperda* on different hosts revealed that, relative growth rate (RGR), relative consumption rate (RCR), efficiency of conversion of ingested food (ECI), efficiency of conversion of digested food (ECD) and approximate digestibility (AD) were found to be maximum on the maize (1.14, 2.71, 41.87%, 46.55% and 89.94%, respectively) and were found minimum on cotton i.e. 0.88, 2.44, 36.21%, 43.97% and 82.35%, respectively. ECD was highest on castor (46.78%) and lowest on mung bean (42.91%). The best host of *S. frugiperda* in laboratory was maize. Cotton and bajara were worst and other hosts were intermediate host.

Keywords: Host preference, digestibility indices, *Spodoptera frugiperda* (Fab.), host plant

Introduction
Host plant is a key determinant of the establishment, growth, survival and fecundity of herbivorous insects. Though many host plants were reported for *S. frugiperda*, every host does not support the pest in the same way. FAW consists of two strains adapted to different host plants. One strain (the "maize strain") feeds predominantly on maize, cotton and sorghum while the second (the "rice strain") feeds primarily on rice and pasture grasses (Dumas *et al.* 2015a) [1]. The fall armyworm, *S. frugiperda* (Lepidoptera: Noctuidae) is native to the America and it is a key pest of maize and many other crops throughout the America. *S. frugiperda* has been reported for the first time in 2016 in Africa, in Nigeria, Sao Tome in Benin and Togo causing significant damages to maize. This pest has been detected for the first time on the Indian subcontinent in mid-May, 2018 in maize fields at the College of Agriculture, (UAHS), Shivamogga (Sharanabasappa *et al*., 2018) [2].
Fall armyworm is of serious concern due to its notorious and polyphagous behaviour. The main reason for its fast spread might be its strong capacity to fly and disperse long distances. The fall armyworm (*S. frugiperda*) is an arthropod in the order of lepidoptera and damaging stage is the larval stage of a fall armyworm moth. The destruction of leaves, stems or flowers of the crop plants by the larva through feeding happens mostly in the last three instars. Young larvae usually feed on leaves creating a characteristic windowing effect. Once the larval stage is completed, the growing moth pupates in the soil for 8-9 days in summer and 20-30 days in cool weather. Larvae are highly polyphagous, and have been documented on over 80 host plant species spanning 23 families (Pashley 1988) [3]. Therefore, there is need to identify the various host of the pest and based on that crop rotation should be adopted. The objective of this study was to determine the best host that support the development of *S. frugiperda* and can be used for mass rearing of *S. frugiperda*. Similarly, the information of life history parameters of *S. frugiperda* on different host plant species will help to make efficient strategies to control this economic pest.

Materials and Methods
Mass rearing of *S. frugiperda*
The larvae of *S. frugiperda* were initially collected from maize fields of Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh. Larvae were placed in round aluminium cages under laboratory condition.

Culture was maintained under laboratory conditions on maize leaves. Fresh food was provided daily, during experimental period. The pupae formed from the larvae were transferred to new cage for the emergence of adult and immediately after emergence, male and female moth (1:1) were transferred in wooden cage measuring 45 cm × 45 cm × 60 cm and all sides of cage was covered with white muslin cloth with long sleeves on two lateral side. The bottom of the cage was covered with one cm thick wet urethane foam. Five per cent honey solution was provided as food for the adults. Tender twig of plant was inserted in conical flask containing fresh water to keep it fresh and turgid which facilitates resting and oviposition of adults. The leaves were observed daily for egg masses. As soon as the egg masses were observed on the leaves, the conical flask was kept in separate cage for hatching. The neonate larvae were carefully transferred with the help of wet camel hair brush on maize leaves. The food was being changed daily in the morning till pupation. The rearing was continued till two consecutive generations on maize to acclimatize and thus, the same was used for further laboratory investigations.

Experimental details

The experiment was conducted at Biocontrol Research Laboratory, Department of Entomology, Junagadh Agricultural University, Junagadh during 2019-20. Different host plants *viz.,* castor (*Ricinus communis* L.), maize (*Zea mays* L.), bajara (*Pennisetum glaucum* L.), mung bean (*Vigna radiate* L.), groundnut (*Arachis hypogea* L.) and cotton (*Gossypium hirsutum* L.) were used for this study. For this purpose, all these plants were sown in small pot in air conditioned room at Biocontrol Research Laboratory. The materials used and methodology adopted during this study is given below.

1. Location : Bio control Research Laboratory, Department of Agricultural Entomology, College of Agriculture, JAU, Junagadh.
2. Year : 2020
3. Design : CRD (Completely Randomized Design)
4. Repetitions : 4
5. Treatments : 6

Methodology

Newly exuviated sixth instar larvae that had been reared on each of the six host plant species for two generations were used in this study. Larvae of approximately same size were selected and individually placed in small containers. The larvae were starved for 6 hrs, and then each larva was individually coded and weighed. Twenty larvae were used in each of the six host plant treatments. The larvae were equally divided into a control group and a treatment group. In the control group, the 10 larvae and 10 fresh leaves from each of the six host plants were individually weighed, dried in at 80°C, and weighed again. The dry weights were used as the standard for all other treatments. In the treatment group, leaves were detached from each of the six host plants were weighed and provided to the 10 larvae. The larvae were fed with the leaves for 48 hrs. The larvae were starved for 6 hrs to allow the larvae to defecate. The larvae, leaf tissues and feces in each dish were weighed and then dried in at 80°C. The dried leaf tissues and larvae were weighed again.

Food consumption and utilization

The observations like weight of dried leaf tissues in the control (A), weight of dried leaf tissues in each treatment (B), weight of dried larva in control (C), weight of dried larva in each treatment (D) and weight of dried feces in each treatment (E) were used for the determination of food utilization rate. Following formulae given by Waldbauer (1968) [4] were used for calculation.

Relative growth rate = D-C/[(C+D) /2]

Relative consumption rate = A-B/[(C+D)/2]

Per cent efficiency of conversion of ingested food= $\frac{(D-C)}{(A-B)} x\ 100$

Per cent efficiency of conversion of digested food = [(D-C) / (A-B-E)] ×100

Approximate digestibility $= \frac{A-B-E}{(A-B)} x\ 100$

All the data which are obtained during experimental work have been analyzed statistically.

Result and Discussion

Relative Growth Rate (RGR)

Relative growth rate (RGR) explains how much dry matter increased in the body of insect per day per gram of body weight. It directly affects speed of development which depends on quality of food and also on some abiotic factors. It is evident from the Table 1 that the relative growth rate significantly varied considerably among the host plants that the larvae consumed. The relative growth rate was the highest on maize (1.14) and it was followed by castor (1.10) and groundnut (0.98). Whereas, lowest growth rate was observed on cotton (0.88) and it was followed by bajara (0.95) and mung bean (0.96).

Consumption Rate (CR)

Consumption rate is an indication of how insects prefer a host through feeding on it. The relative consumption rate was found significantly the highest, when the larvae fed on maize (2.71), followed by that on castor (2.70), groundnut (2.65), mung bean (2.63) and the lowest on cotton (2.44) followed by bajara (2.62).

Efficiency of Conversion of Ingested Food (ECI)

ECI value is an indication of conversion of overall ingested food into various nutrients. The data present in Table 1 and showed that there was variation in ECI among the different hosts. The efficiency of conversion of ingested food was significantly highest on maize (41.87%), followed by that on castor (40.86%), intermediate on groundnut (37.10%), mung bean (36.57%), bajara (36.43%) and lowest on cotton (36.21%).

Efficiency of Conversion of Digested Food (ECD)

The ECD measures the efficiency with which assimilated food is converted into insect biomass. Data presented in Table 1 revealed that the efficiency of conversion of digested food was recorded significantly higher when the larvae fed on castor (46.78%), followed by that on maize (46.55%), then that on cotton (43.97%), and lowest on groundnut (42.98%), followed by mung bean (42.91%) and bajara (43.38%).

Approximate digestibility (AD)

It explains how much amount of food has been digested from the amount of food ingested. Perusal of the data in Table 1 revealed that the approximate digestibility of larvae on the host plants differed significantly and was the highest on maize (89.94%) and castor (87.34%) than on groundnut (86.32%) and lowest on cotton (82.35%), followed by bajara (83.98%), mung bean (85.23%).

Our data showed that all nutritional indices varied when *S. frugiperda* fed on the different host plants. The results showed similarity to the earlier findings of Balasubramanian *et al.* (1985) [5] who reported that food conversion efficiencies on different host plants vary considerably by *S. litura* larvae and by insects in general. Silva *et al.* (2017) [6] reported that the cotton and soybean leaves were revealed to be less adequate hosts for the development of *S. frugiperda* when compared to the grasses. Narvekar *et al.* (2018) [7] studied on the host preference and digestibility indices of *S. litura* (Fab.) on different host plants under laboratory condition and revealed that, efficiency of conversion of ingested food (ECI), Efficiency of conversion of digested food (ECD), Consumption rate (CR) and Relative growth rate (RGR) were found to be maximum on the castor (21.82%, 23.14%, 0.92 and 3.51, respectively).

The current data showed that *S. frugiperda* had highest relative growth rate and consumption rate on maize as compared with other host plants. However, the larvae were more efficiently converting maize leaves into their biomass than other plant tissues as in these, highest approximate digestibility, efficiency of conversion of ingested food and digested food recorded. The overall results revealed that maize as the most suitable host for overall development of *S. frugiperda* as data on various parameters of biology and digestibilty indices of *S. frugiperda* were also supportive to this statement. The next best hosts were castor, groundnut and mung bean. Similarly bajara and cotton emerged as poor hosts.

Table 1: Nutritional indices of *S. frugiperda* larvae feeding on different host plants

Host plants	Category				
	*Relative growth rate	*Relative consumption rate	**Efficiency of conversion of ingested food	**Efficiency of conversion of digested food	**Approximate digestibility
Castor	1.05(1.10)	1.64(2.70)	39.73(40.86)	43.15(46.78)	69.22(87.34)
Maize	1.07(1.14)	1.65(2.71)	40.32(41.87)	43.02(46.55)	71.51(89.94)
Bajara	0.97(0.95)	1.62(2.62)	37.09(36.43)	41.20(43.38)	66.45(83.98)
Mung bean	0.98(0.96)	1.62(2.63)	37.21(36.57)	40.92(42.91)	67.55(85.23)
Groundnut	0.99(0.98)	1.63(2.65)	37.52(37.10)	40.96(42.98)	68.35(86.32)
Cotton	0.94(0.88)	1.56(2.44)	36.98(36.21)	41.53(43.97)	65.17(82.35)
S.Em.±	0.03	0.02	0.72	0.50	1.02
C.D. at 5%	0.08	0.05	2.13	1.48	3.04
C.V. %	5.17	2.15	3.76	2.39	3.01

*Square root transformed values **Arcsine transformed values Figures in parenthesis are original values

Conclusion

From the present studies, the host preference and digestibility of *S. frugiperda* on different host plants is important to know the best host that support the development of *S. frugiperda* and can be used for mass rearing of *S. frugiperda*. The best host of *S. frugiperda* in laboratory were maize and castor. Cotton and bajara were worst and other hosts were intermediate host.

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